Farnell

SUPPLY UNITS
STABILISED VOLTAGE CURRENT
L30 SERIES Issue 4.

INSTRUCTION BOOK

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FARNELL INSTRUMENTS LIMITED

SUPPLY UNITS
STABILISED VOLTAGE CURRENT
L30 SERIES Issue 4.

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SECTION I

INTRODUCTION

This manual covers the MK II L30 series of D.C. stabilised voltage/current supply units. The circuit diagram contained in the manual is for the particular unit type supplied.

Twin units are designated L30 -/T and consist of two appropriate L30 units mounted in the one case. The two outputs are completely independent. They may be used as separate supplies or alternatively may be connected in series or parallel, to provide higher output voltages or currents than can be obtained from a single L30 supply.

The semiconductor complement of these supplies is silicon throughout, permitting operation to 45°C ambient at full specified output.

The output voltage is adjusted by means of two controls on the front panel marked " COARSE " and " FINE."

The output voltage or current is monitored by a switched voltmeter/ammeter.

Overload protection is provided to protect the power unit and apparatus, being supplied by limiting the output current to a set value. This value is adjustable from zero to the maximum current of the unit by means of a control on the front panel marked " CURRENT LIMIT." The circuit will automatically reset when the overload is removed.

The instrument will operate from mains supplies of 210, 220, 230 and 240v. A.C. at 50/60 Hz.

(An alternative instrument is manufactured for use with mains supplies of 105—120v.).

Certain units in the range are fitted with internal overvoltage protection (see Section IV) when the unit output exceeds a level set by means of a front panel control, the unit output is clamped to a low value by means of a thyristor crowbar circuit.

SECTION II

OPERATING INSTRUCTIONS

Care should be taken to ensure that the input selector on the rear of the unit is set to match the mains supply from which the supply is to be operated.

The mains lead is wired as follows :—

BROWN Mains Line.
BLUE Mains Neutral.
GREEN/YELLOW Earth.

NORMAL CONSTANT VOLTAGE OPERATION

Before connection to the mains supply is made, the output "ON/OFF" switches, should be set to "OFF". The link on the bottom of the unit should be in the "CV" position.

With the mains supply connected, the mains "ON/OFF" switch is set to "ON" and the mains indicator lamp should light.

With the meter switch set to "VOLTS", the required output voltage is selected by adjusting the "COARSE" and "FINE" voltage controls on the front panel and the current limit control set to maximum (fully clockwise). Unless use of the current limiting is to be made, the load is now connected and the output "ON/OFF" switch set to "ON". Output current can be monitored by setting the meter switch to "CURRENT".

CURRENT LIMIT SETTING

If a certain maximum current must not be exceeded or a roughly constant current is required, use may be made of the current limiting facility, maximum current being set by the front panel control marked "CURRENT LIMIT".

(1) *APPROXIMATE CONSTANT CURRENT OPERATION*

With the mains supply connected to the unit, mains and output switches set to "ON", the meter switch set to "CURRENT" and the output voltage controls set to maximum, the positive output terminal is linked to the negative output terminal and the current limit control set to give the required current. On removal of the link and connection to the load, the unit will give a roughly constant current over a voltage range from zero to the maximum specified output voltage depending on the load resistance.

(2) *CURRENT CEILING OPERATION*

If a certain maximum current is not to be exceeded then the setting up procedure is as follows :—

With the mains supply connected to the unit, mains and output switches to "ON", the meter switch set to "CURRENT" and the voltage controls set to the required value, a variable load is connected to the unit and is set to give the required maximum current. The current limit control is then adjusted until the current just starts to fall. The unit will now prevent more current than this value being drawn from it. It is advised that this current "ceiling" is set to approximately 10% in excess of the expected maximum to prevent any modification to the voltage regulation characteristic. The variable load is now disconnected and the unit is ready for use.

ACCURATE CONSTANT CURRENT OPERATION

(*See Fig.* 1)

If a fixed resistor Rs is connected between the positive output terminal and the "I const" or "—F/B" terminal, the link on the bottom of the unit set to CI, and the load RL between the "I const" or "—F/B" terminal and the "O/P - ve" terminal, then the unit will keep the voltage across Rs constant. Thus a constant current will flow in Rs. Since RL is in series with Rs, the same current will flow in RL.

The value of Rs is given by :—

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$$R_S = \frac{V}{I\ out} - R_L\ max.$$

Where V is the maximum specified output voltage of the unit.

Rs must have a power rating well in excess of the power it dissipates in order that the change in resistance due to self heating is minimised.

The power dissipated in Rs is given by :—

$$P(R_S) = I\ out^2\ R_S.$$

Rs is then connected between the "O/P+" and "I const" terminals. The "I const" or "—F/B" terminal is shorted to the "O/P—" terminal and the "VOLTAGE ADJUST" controls set until the meter reads the required output current. The "short" is then removed and the load connected in its place. The output current will be constant with the same specification as the constant voltage specification with the load varying from zero to RL max.

NOTE :—

The front panel "CURRENT LIMIT" control should be set to maximum for this mode of operation.

FOUR TERMINAL OPERATION

Certain units have been provided with four terminal output to enable the correction of resistive drop in connecting leads. When this correction is not required, the +F/B and +O/P terminals should be linked together and the —F/B and —O/P terminals should be linked together. When correction is required the links should be removed. The load should be connected to the +O/P and —O/P terminals and the +F/B and —F/B terminals connected through separate wires to the appropriate ends of the load. It may be necessary to decouple at the load with an electrolytic capacitor to prevent instability in this connection.

OVER-VOLTAGE PROTECTION

On units fitted with over-voltage protection the over-voltage trip level adjustment is on the front panel of the unit, and the current limit control on the back of the unit.

To set a given trip level, set the output voltage to this level, and adjust the "OVERVOLTAGE" control until the output voltage falls to a low level.

Set the voltage adjustment controls fully anti-clockwise, the output (or mains) switch to off, and then on. This resets the overvoltage trip. Re-adjust the output voltage controls to give the required operating voltage.

SECTION III

CIRCUIT DESCRIPTION

The circuit employs series regulator transistors driven via emitter followers from a differential amplifier which compares the voltage of a zener diode reference with a proportion of the output voltage derived from a resistive potential divider.

The mains supply is connected via fuse F1, SW1 and the input selector to MT1. The main secondary winding supplies a bridge rectifier, reservoir capacitor system which provides the main unregulated D.C. line. The positive line is connected via the series regulator transistors and SW2 to the positive output terminal. The negative line is connected via fuse F2 to the negative output terminal.

Supplies for the amplifier and reference section are derived from the auxiliary 36 volt secondary winding, via rectifier diodes D5 and D6 and smoothed by capacitor C2. The unstabilised reference line is fed to zener diode Z1 via resistor R2. The semi-sta bilised voltage across Z1 is fed to zener diode Z2 and Z4 via R3 providing 10 volts positive and approximately 5 volts negative with respect to the positive output terminal. The voltage across Z2 feeds the reference zener diode Z3 and potential divider chain R7, T1, P1 and P2, via Resistor R4.

The base of VT1 and the negative of Z3 are connected to the positive output terminal. R7 and T1 are connected between the positive of Z3 and VT2 base via R8. Any difference between the voltages at VT1 and VT2 bases is amplified at the collector of VT2 and applied to VT3 base. After further amplification at VT3 collector the signal is applied to the emitter followers of the series regulator stage in such a sense as to oppose the original signal at VT1 and VT2 bases. The action of the loop is therefore to maintain zero voltage between VT1 and VT2 bases.

Output voltage is determined by :—

$$\frac{\text{Vref (P1 + P2)}}{\text{R7 + T1}}$$

Overload protection is provided by VT4 and VT8. As output current increases, the voltage drop across R17 increases until the base of VT4 is sufficiently positive to turn it on. This diverts current from the series regulator stage, thus reducing the output voltage. On further increase in load, VT4 will maintain a roughly constant voltage drop across R17 which gives a roughly constant current output. The point at which the initial current limit occurs is set by P3 and the maximum current limit point is set by T2.

OVERVOLTAGE PROTECTION

On units fitted with overvoltage protection, this is provided by means of a Thyristor "crowbar" connected across the output terminals, and driven from a voltage comparator amplifier which compares a fraction of the output voltage with a reference zener diode. R1a, Z1a, R7a and VT1a, comprise a constant current source to feed the reference zener diode Z2a, Z9a and R10A feed a fraction of this voltage to VT3a base. VT3a and VT4a are the comparator transistors, the base of VT4a being fed from potential divider P1a, R6a and R13a. If the output voltage exceeds a level determined by this potential divider VT4a conducts, driving VTZa on. The drive then available from VT2a collector then fires SCR1a which short circuits the output terminal.

SECTION IV

SPECIFICATION

Mains Supply

210, 220, 230 or 240 volts 50/60 Hz.

Alternatively, instruments may be supplied for 105, 110, 120 volts 50/60 Hz.

Output Voltage and Current Ranges

SINGLE UNITS

L30A	0 — 50V.	0.5A.
L30B	0 — 30V.	1A.
L30C	0 — 10V.	3A.*
L30D	0 — 30V.	2A.
L30E	0 — 30V.	5A.
L30F	0 — 12V.	10A.*

TWIN UNITS

L30AT	2 × 0 — 50V.	0.5A.
L30BT	2 × 0 — 30V.	1A.
L30DT	2 × 0 — 30V.	2A.

*Fitted with overvoltage protection.

Mains Variation Tolerated

± 10% of Nominal.

Output Voltage Variation for ± 10% Mains Change

Less than .01% or 1mV whichever is the greater—short term.
Less than .02% or 2mV whichever is the greater—long term.

Output Voltage Variation for Zero to Full Load Change

Less than .01% or 2mV whichever is the greater—short term.
Less than .02% or 4mV whichever is the greater—long term.

Output Current Variation for 10% Mains Change (Accurate Constant Current Operation)

Less than .01% or 1mA whichever is the greater—short term.
Less than .02% or 2mA whichever is the greater—long term.

Output Current Variation for Zero Resistance to Max. Resistance Change (Accurate Constant Current Operation)

Less than .01%—short term.
Less than .02%—long term.

Output Current Variation for 10% Mains Change (Approximate Constant Current Operation)

Less than 1%—short term.
Less than 2%—long term.

Output Current Variation for Zero Res.—Max. Res. Change (Rough Constant Current Operation).

Less than 2%—short term.
Less than 3%—long term.

Ripple Voltage at Full Load

Less than 1mV peak to peak.

Ripple Current at Full Load

Less than 1mA peak to peak.

Overload Protection

Current Limiting.

Overvoltage Protection

Thyristor "crowbar" trip. Trip level adjustment approx. 3.2V. to 14V., temp. coefficient of trip level 0.04% /°C. typical.

Max. Operating Temperature

45°C.

Temperature Coefficient

±0.02% per °C. Typical.

Output Impedance

See Fig. (2).

SECTION V

INTERNAL ADJUSTMENT

Units are set up before leaving the factory, but in the event of future mis-alignment the setting-up procedure is as follows :—

VOLTAGE ADJUSTMENTS

(1) An accurate voltmeter is connected between the "O/P—" and "O/P+" terminals, with an f.s.d. compatible with the specified maximum output voltage of the unit.

With the unit switched on, the link on the bottom of the unit set to "CV" and the "VOLTAGE ADJUST" controls fully clockwise, T1, on the circuit board, is adjusted to give the specified maximum output voltage.

(2) With the meter switch set to "VOLTS", T3 is now adjusted so that the front panel meter reads full scale.

CURRENT ADJUSTMENTS

(1) An accurate ammeter with an f.s.d. compatible with the specified maximum output current of the unit, is connected in series with a variable load between the "O/P+" and "O/P—" terminals.

With the unit switched on, the link on the bottom of the unit set to "CV" and the "CURRENT LIMIT" control fully clockwise, the load is adjusted to give 10% in excess of the specified maximum output current. T2 is then adjusted until the current just starts to fall.

(2) With the meter switch set to "AMPS", the load is re-adjusted to give the specified maximum output current and T4 is adjusted so that the front panel meter reads full scale.

SECTION VI

TYPICAL PERFORMANCE AND APPLICATIONS

1. *VOLTAGE PROGRAMMING*

All units can be programmed by means of external resistors to any voltage below the specified maximum voltage, the programming terminal being the "I const" or "—F/B" terminal. The link on the bottom of the unit is set to "CI" and the "VOLTAGE ADJUST" controls turned fully anticlockwise. The programming resistor should now be connected between the "I const" and "O/P—" terminals.

The value of programming resistor is given by :—

$$R\ prog = \frac{25{\cdot}25}{50} \times V\ required,\ Kilohms\ (L30A)$$

$$R\ prog = \frac{25.25}{30} \times V\ required,\ Kilohms\ (L30B,\ D\ \&\ E)$$

$$R\ prog = \frac{5.1}{10} \times V\ required,\ Kilohms\ (L30C)$$

The tolerance on V required for an accurate R prog is ± 10%. In order to obtain greater accuracy, the voltage of the reference zener-diode Z3, (V ref) and the resistance of R7 + T1 must be determined. R prog is now given by :—

$$R\ prog = \frac{R7 + T1}{V\ ref} \times V\ required,\ ohms$$

The tolerance on V required for an accurate R prog is now the tolerance on the V ref measurement plus the tolerance on the R7 + T1 measurement.

2. *SERIES OPERATION*

Units may be connected in series ONLY IN THE "CV" MODE OF OPERATION.

3. *PARALLEL OPERATION*

(*A*) *"CV" OPERATION*

Units which are set to approximately the same output voltage may be connected directly in parellel. On increasing load, the unit having the highest output voltage will carry the load until it current limits, thereafter the unit having the next highest

voltage will supply the extra current until it limits, and so on. A typical output characteristic for a parallel combination of three units is shown in Fig. (3).

The characteristic shows a series of descending steps in output voltage at the current limit points of individual units, the amplitude of the steps depends on how closely the output voltages have been set and it may not be possible to adjust this to better than 50mV.

It is recommended that not more than three units are paralleled in this way.

(*B*) *"CI" OPERATION*

Units can be connected directly in parallel in either "APPROXIMATE CI" or "ACCURATE CI" operation, the load current being the sum of the two output currents, Fig. (I) shows the connections for "ACCURATE CI" operation.

4. *TYPICAL PERFORMANCE*

Stability

Output variations are due in the main to the following causes :—

Load Change.
Mains supply change.
Component temperature change.

(*a*) ***Load Change***

(I) Steady load—For a change in steady load from zero to full load, the typical change is :— 1mV at full voltage output.

(II) Transient Response—The typical response to a pulsed load is shown in Fig. (4).

(III) Output Impedance.

For alternating load superimposed on a steady load, the output impedance of the supply increases with frequency due to the fall off in gain of the amplifier until it is determined only by the capacitor across the output terminals.

A typical output impedance/frequency curve is shown in Fig. (2)

(b) Mains Supply Change

Short term mains variations of up to 10% give corresponding variations of up to 0.01% on the output. Surges on the mains supply in the form of short rise time pulses can be fed on to the output by stray capacity. Where these conditions exist a capacitor suppressor filter should be connected in the mains lead.

(c) Component Temperature Change

Output variation is caused by component value changes due to temperature change. The temperature change can be (I) as a result of ambient change, or (II) as a result of unit internal temperature change, caused by changing internal dissipation from a change in load or supply to the unit.

(I) Ambient Change—The typical temperature co-efficient of output voltage is .02% per degree centigrade of ambient change

(II) Internal Change—Fig. (5) shows typical output variations caused by mains change and load change plotted against time.

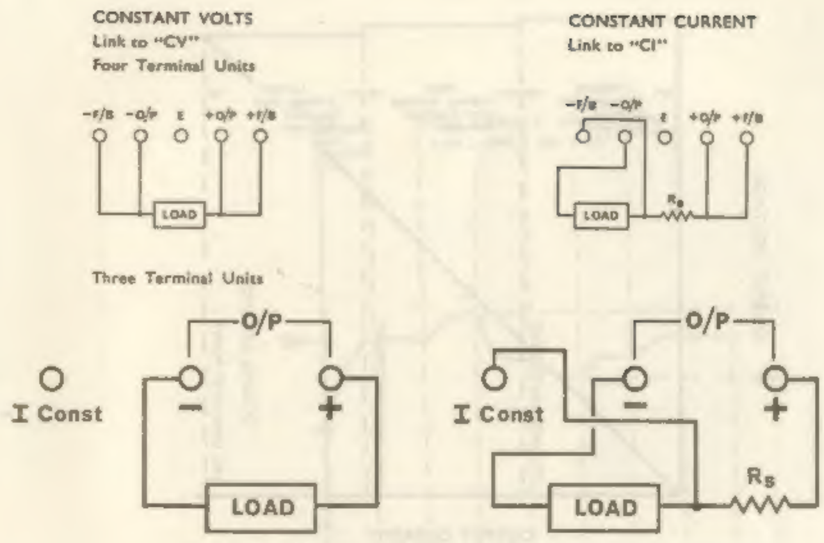


Fig. 1. CV and CI Connections

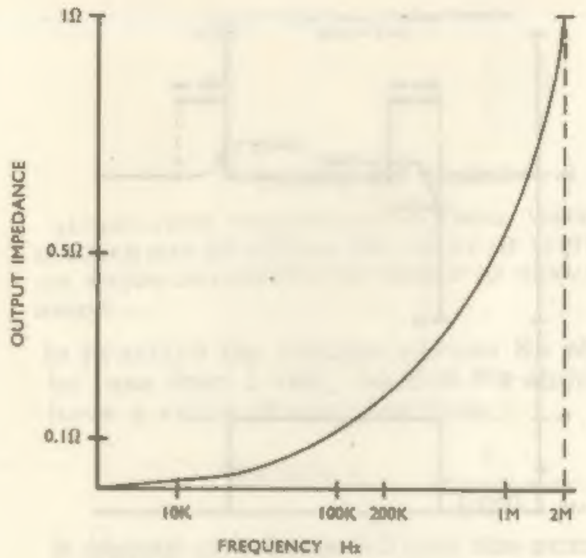


Fig. 2. Output Impedance

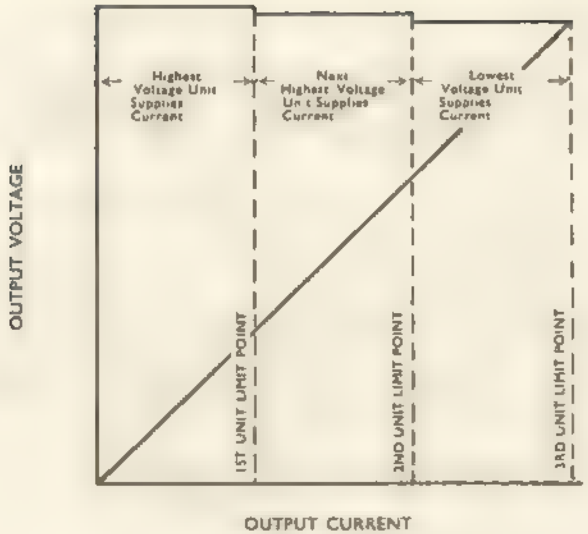


Fig. 3. Parallel Operation

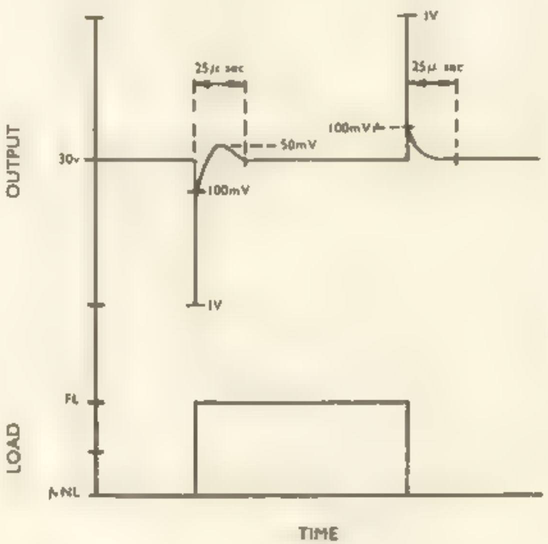


Fig. 4. Pulse Response

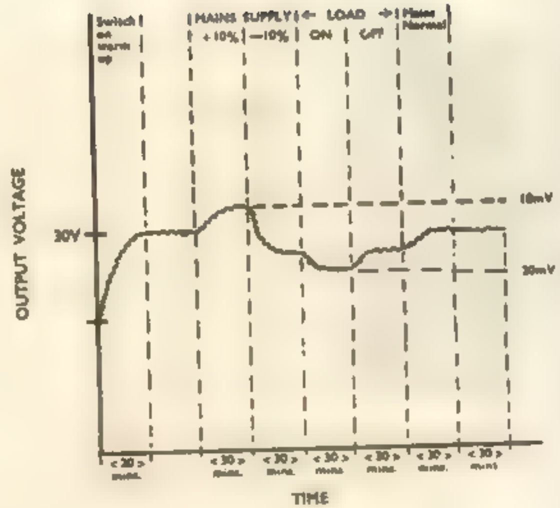


Fig. 5. Typical Output Voltage Variation against Time

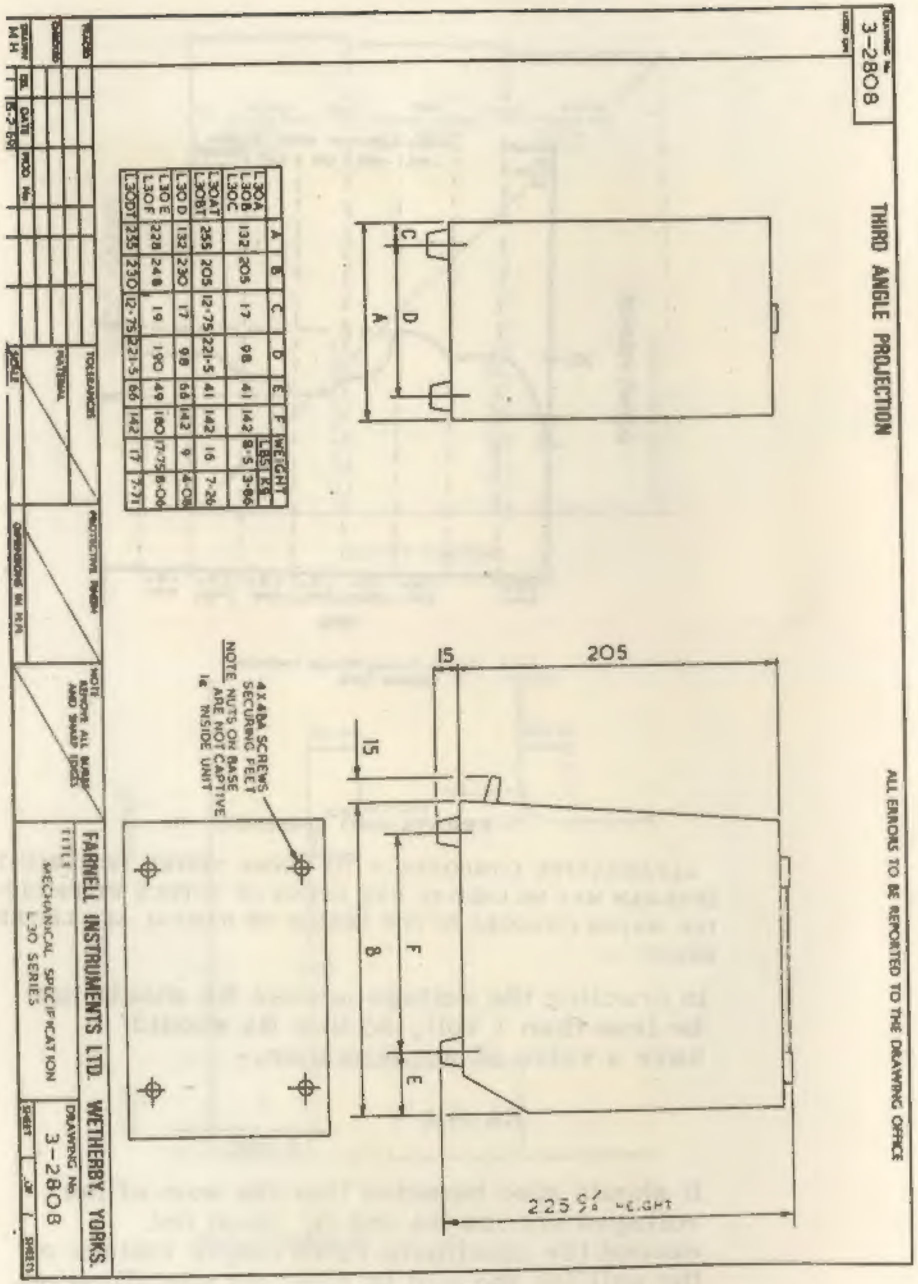
ERRATA AND ADDENDA

ALTERNATIVE COMPONENTS TO THOSE LISTED ON CIRCUIT DIAGRAM MAY BE USED IN THE EVENT OF SUPPLY DIFFICULTIES. MAJOR CHANGES TO THE DESIGN OR MANUAL ARE LISTED BELOW —

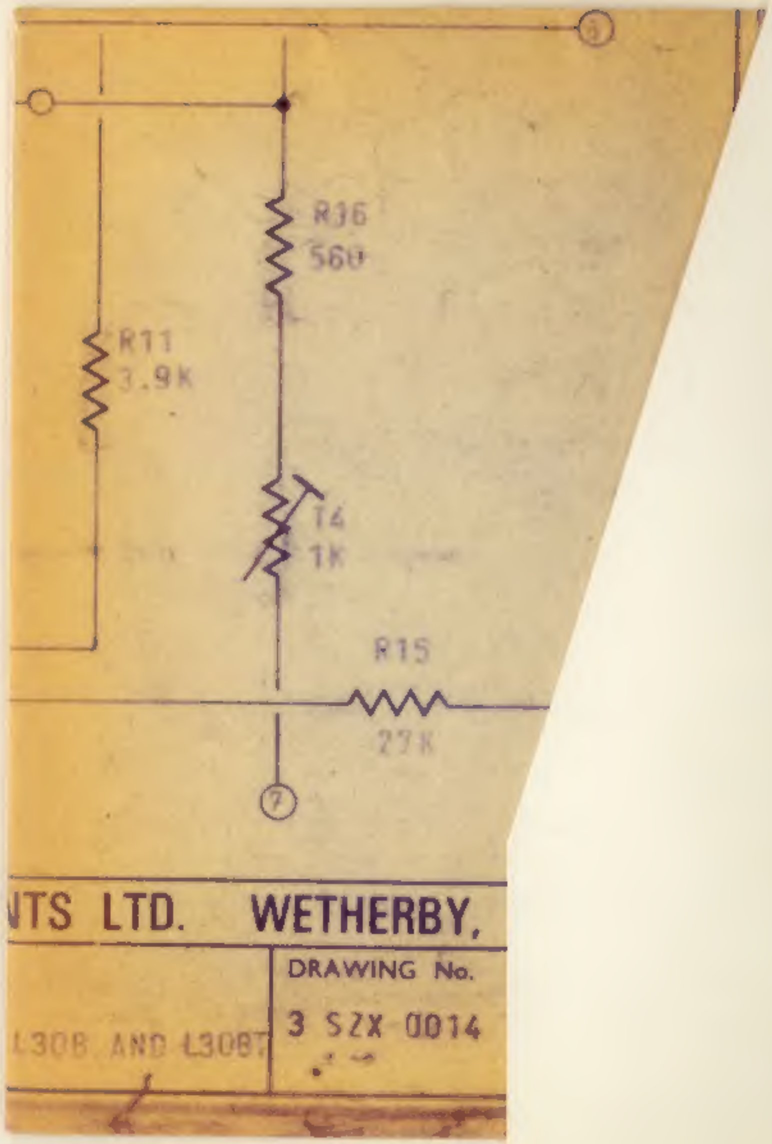
In practice the voltage across Rs should not be less than 1 volt, so that Rs should have a value of not less than:-

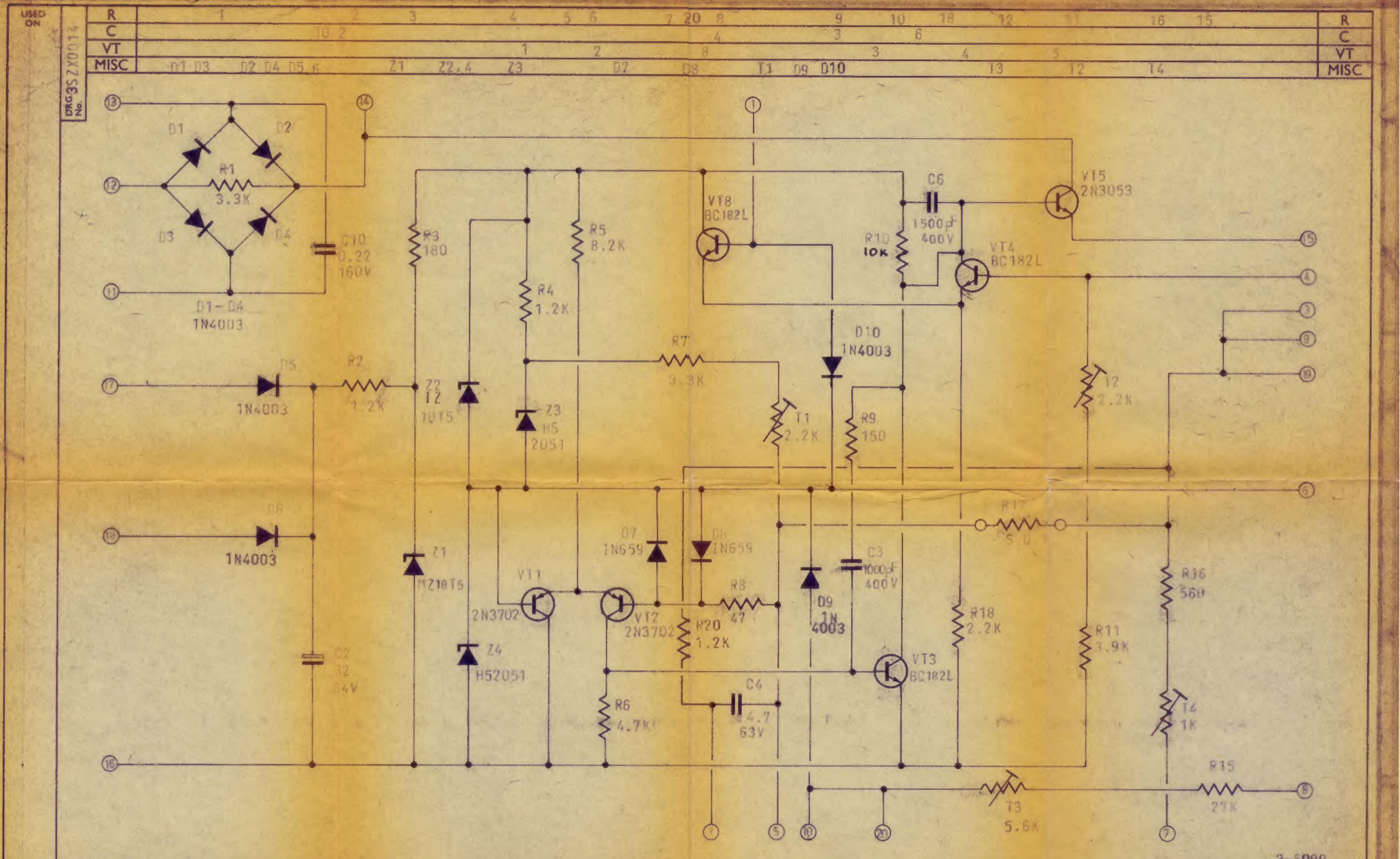
$$\text{Rs min} = \frac{1}{\text{I out}}$$

It should also be noted that the sum of the voltages across Rs and R_L must not exceed the maximum rated output voltage of the unit for the unit to meet its specification.



	A	B	C	D	E	F	WEIGHT LBS	WEIGHT KG
L30A L30B L30C	132	205	17	98	41	142	8·5	3·86
L30AT L30BT	255	205	12·75	221·5	41	142	16	7·26
L30D	132	230	17	98	66	142	9	4·08
L30E L30F	228	248	19	190	49	180	17·75	8·06
L30DT	235	230	12·75	221·5	66	142	17	7·71





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CHECKED		B	9-8-72	Q1592
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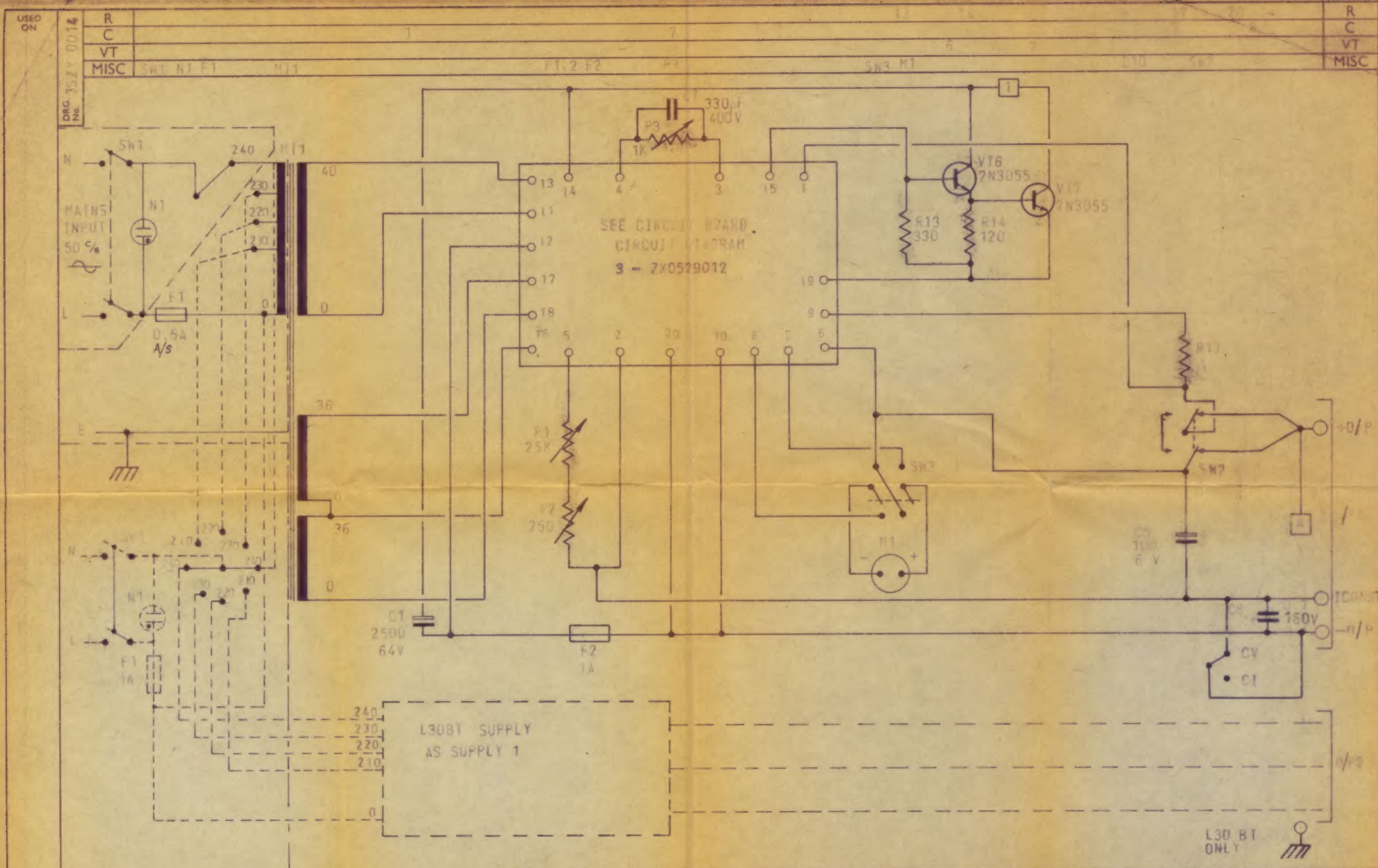
DRAWN	PMR	ISS.	DATE	MOD. No.
		1	6:4:71	–

NOTE :—
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

CIRCUIT BOARD
CIRCUIT DIAGRAM
L30B AND L30BT

DRAWING No.
3 SZX 0014



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		A						
DRAWN		ISS.	DATE	MOD. No.				

NOTE:—
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

CIRCUIT DIAGRAM
L30B AND L30BT

DRAWING No.
3-6100
3SZX 0014